frame vanish on account of the invariance. Equations so derived are mathematical identities which cannot be controverted.

(2) The vanishing of the variation for *all* small changes of the parameters is a possible form for a law of nature. Equations so derived rest on a particular hypothesis which challenges criticism.

We wish that the author had kept the results of these two applications distinct. We believe that most of the ascertained laws of physics are derivable by the first application, and the second is responsible for some additional results which cannot be tested and do not appear to us particularly probable.

The translator of such a book as this has our sincere sympathy. He has done a useful work which yet falls far short of complete success. There are many passages in the original which we have turned to again and again, and only very slowly grasped their meaning; others still defeat us. It was not to be expected that the translator would penetrate the thought behind them, and he has evidently given up the attempt to make his rendering convey any possible sense. We would not recommend any one to make a profound study of this work without having the German original at hand to consult when a difficulty is encountered. There are other mistakes harder to excuse. Weyl's treatment of space turns on the two conceptions of affine and metrical geometry, and it is impossible to proceed without mastering these. But the exposition of affine geometry on p. 18 refers continually to postulates I and II, and the reader will search in vain for any postulates so indicated. In the German edition a misprint of 1 for I is comparatively harmless; but in the English edition the further substitution of 2 for II extinguishes the reader's last hope of discovering what the argument refers to. On pp. 141-2, two axioms are printed as though they were headlines of the paragraphs following. Absurd mistranslations such as "mass of the earth" for "mass of the world" on p. 296 will probably not do much harm, though they shake our confidence. All the same, there is much good work in the translation, and those who are struggling to master Weyl's indispensable treatise will welcome the partial aid which it affords.
A. S. E.

New Methods of Arctic Exploration.

The Friendly Arctic: The Story of Five Years in Polar Regions. By Vilhjahmar Stefansson. Pp. xxxi + 784 + plates. (London: Macmillan and Co., Ltd., 1921.) 30*s.* net.

NO such original and assertive explorer of the Arctic regions as Mr. Stefansson has appeared since Dr. Nansen startled the admirals by dispensing with a line of retreat. Mr. Stefansson's views are however, far more upsetting than those of Dr. Nansen, for he denies practically every theory and many reputed facts regarding the North Polar area, and contemns almost all the long-established methods of Arctic travel.

We cannot go on to Mr. Stefansson's vindication of his own powers as a pioneer without first deprecating his contemptuous tone with regard to arm-chair geographers and their views. Those harmless drudges do their best to follow the published narratives of explorers and to reconcile the contradictions between successive travellers' reports. If they say in their compilations that the Arctic Sea in its farther recesses is devoid of life it is because explorers have told them so, and if they dwell upon the hardships and dangers of Arctic explorations it is because earlier and less expert explorers did suffer and perish in the attempt to do, amid difficulty and pain, what proves easy and pleasant to Mr. Stefansson. We gladly acknowledge that Mr. Stefansson treats Peary as a great and successful explorer, and does full justice to McClintock's marvellous sledge journeys on the Franklin search; but he would have thought so much more of them if they had seen how easy it was to "live off the country"!

In pp. 30-32 much is made of the assumed ignorance on the part of Sir John Murray that sea-ice after long exposure on the surface of a floe can yield drinkable water. It seems to us that Sir John Murray probably controverted Mr. Stefansson's statement on this point not from ignorance but merely in order to test his character, for it was a common thing with Murray to see if a young man who knew something could be shaken in his confidence as to his own knowledge by the weight of an older man's authority. If Mr. Stefansson had wavered, as we are very sure he did not, Sir John Murray would have thought the less of him. As a matter of fact, we know that Murray was greatly impressed by the young Canadian's knowledge and fitness. With this book before them we are sure that the works of oceanographers and arm-chair geographers will henceforth be purged of some errors and fortified by many new facts; but the whole load of learning left by the old heroes of the North will not, on that account, be thrown into the sea like Stefansson's despised canned goods.

In 1913 the Canadian Government took over and financed an Arctic expedition which Mr. Stefansson had been organising in co-operation with the National Geographic Society of Washington and the American Museum of Natural History. These institutions withdrew their claims and so Stefansson's third Arctic expedition was purely Canadian. A great programme was prepared for work in two divisions, a northern in a strong whaler, the *Karluk*, under Mr. Stefansson himself with a large staff and complete oceanographical equipment; and a southern for work on the coast of the continent under Dr. Anderson, who was second in command, and provided with a smaller vessel. The southern party proceeded on the whole according to plan; but the *Karluk* forced her way into the ice north of Alaska on August 13, 1913, and remained fast, drifting westward. On September 20, when the ship was ten miles off the land Stefansson thought it right to go ashore for a few weeks' caribou hunting; but the ship had disappeared when he was ready to return, and after quite old-fashioned difficulties and hardships, including the crushing and sinking of the ship, most of the men succeeded in reaching Wrangel Island off the coast of Siberia and were ultimately saved. Mr. James Murray, the biologist, and Dr. Mackay, both of whom had been with Sir Ernest Shackleton in the Antarctic, were amongst those who perished on the ice.

Ignorant of the fate of the *Karluk*, and deprived by her loss of all the carefully prepared equipment and trained assistants, Stefansson had to decide whether he should accept failure or put to a test his long-cherished idea of living on the resources of what he had come to look on as a friendly Arctic. He chose the latter alternative, found two old friends amongst the Arctic traders, named Storkerson and Andreasen, who were willing to take risks, got together some sledges and dogs, a few instruments, and a large quantity of ammunition, and on March 22, 1914, started on a great journey over the sea-ice from Marten Point in 70° N. No one on shore expected to see him again. A support party was sent back on April 5, when fifty miles from shore, and the three men with six dogs and provisions for thirty days marched northward over the floes along the meridian of 140° W. By May 5, they had reached 74° N. in 135° W., and seals and bears kept them in food and fuel in an eastward march until they landed on Banks Land on June 25, after travelling a thousand miles, never having been hungry, cold, or tired, and the dogs in better condition than at the start.

The summer was spent hunting and exploring in the unknown interior of Banks Land; the ship appointed to bring supplies arrived, and the winter over Stefansson started again north-westward over the sea-ice, reaching almost 77° N. in 130° W. early in May 1915. From this point he travelled due east to Prince Patrick Land, skirted its north-west coast, and to the north-east of it discovered a new land (Borden Island) in 78° N. 115° W., and the summer being then so far advanced as to make travel over the sea-ice very difficult he hurried back almost 600 miles by the west coast of Melville Island to his old base in Banks Land. Thence opportunity was taken of a chance trader, whose ship Stefansson purchased as a matter of course, to pay a brief visit to the comparative civilisation of Herschel Island, but on returning to Banks Land the party made an interesting journey eastward to visit the Copper Eskimos of Victoria Island. After wintering in Banks Land, Stefansson in the spring of 1916 made a journey across Melville Island to Borden Island, thence north-eastward to 80° N., where another new land, Meighen Island, was discovered in 100° W., and on his way back he found a third new land, Longheed Island, in 77° N. 105° W. The winter quarters for 1916–17 were in Liddon Gulf, Melville Island, classic ground of the Franklin search.

Early in 1917 Mr. Stefansson was again on his way north, this time along the eastern coast of Borden Island and onwards over the sea-ice almost to 81° N. in 110° W. Here his two companions, who were new hands on this occasion, broke down from scurvy, due to their surreptitious diet of tinned foods during the previous winter, and the most promising of all these wonderful journeys had to be cut short. The return journey reads like a sheer romance, and Stefansson well says that if Stevenson had only known of facts like these he would never have had to invent the plot of "Treasure Island." The accumulating interest of chapters 59 to 63 is tremendous, and will prove to most European readers a revelation of what is possible in Arctic America. On September 13 Stefansson landed from his stranded steamer at a little harbour in Alaska, and here his luck deserted him, for after planning another trip into the Beaufort Sea he was attacked successively by typhoid fever, pneumonia, and pleurisy, and 1918 was well advanced before he could leave the hospital in Fort Yukon that nothing but his indomitable spirit enabled him to reach. His old friend Storkerson undertook an eight months' journey over the Beaufort Sea north to 74°, then drifting on a floe to follow the currents, and he returned safely, showing that he also could live on the natural bounty of the friendly Arctic.

We have given a condensed narrative, for the book is confused by digressions which obscure the sequence of events. The digressions, however, are full of interest, telling much of the habits of caribou, musk-oxen, seals, polar bears, and Arctic foxes, and more of Mr. Stefansson's own special subject—the habits and beliefs of the Eskimo, and the prejudices as to diet of all sorts of men and dogs.

The scientific results are being worked out at Ottawa, and we can refer here only to the unique value of the soundings taken by Stefansson and Storkerson in the Beaufort Sea. These determine the position of the Continental Shelf on several lines at right angles to the coast of America and to the western islands of the Arctic archipelago. They also point to great possibilities in the way of more detailed oceanographical work by sledge journeys in the future.

HUGH ROBERT MILL.

An Epic of Science.

The Torch-bearers. By Alfred Noyes. Pp. lx + 281. (Edinburgh and London: W. Blackwood and Sons.) 7*s*. 6*d*. net.

EPIC is perhaps too large a word to apply to this beautiful book, though Mr. Noyes himself suggests it in his preface. There is, as he says, "an epic unity—a unity of purpose and endeavour"—in the story of scientific discovery, and "the great moments of science have an intense human interest and belong essentially to the creative imagination of poetry." The world of science and of poetry, therefore, both owe Mr. Noyes a great debt of gratitude for his attempt—the first of the kind—to bring them together; and, apart altogether from the high scope which he announces, every reader who submits himself fairly to the influence of his verse will be carried away by the charm of the language, the human, sometimes humorous, touches of character, and the triumphs, mixed with pathos, of the story.

We are told in the preface that this volume is the first of a trilogy, though the subjects of the two which are to follow are not revealed. This one deals with the pioneers of astronomy, and the other two might well be given, one to the discoverers of physics and chemistry, ending in the marvels of the electrons, and the other to the story of evolution, linking the record of geology with the gradual establishment of the continuity of organic structure. These we shall await with intense interest, and with full confidence that Mr. Noyes will do justice to the broad outlines of the theme and its human bearings, without too much concern as to the absolute accuracy of his account in details. Of course there are mistakes here and there; Kepler's laws are not quite accurately given. But what a *tour de force* to present them at all, approximately and attractively, in poetic form! Of course, too, there are plenty of prose-like lines, about which some of the critics in the press have made merry. But at the most they are a very small proportion of the whole, far smaller than in any of the long narrative poems of Wordsworth.

Speaking of Wordsworth, it is a little strange that Mr. Noyes does not invoke his great authority in favour of his enterprise in this trilogy. He invokes Matthew Arnold, who prophesied forty years ago that poetry would carry on the purer fire of human thought and express in new terms the eternal ideas of faith and hope which must be the constant stay of the human race. But Wordsworth, in the Preface to the second edition of the "Lyrical Ballads," came nearer still to Mr. Noyes's idea. He showed how the Poet, being in that respect the Man, *par excellence*, looked always "before and after" and held our human ideals together. He carried everywhere relationship and love, and wove into the fabric of his vision all that mankind has ever done or known or dreamt. Thus the material of science is just as fit an object of the poet's art as any upon which it is more usually employed. "If the time should ever come when what is now called science, thus familiarised to men, shall be ready to put on, as it were, a form of flesh and blood, the Poet will lend his divine spirit to aid the transfiguration, and will welcome the Being thus produced as a dear and genuine inmate of the household of man."

More than a hundred years have passed since Wordsworth made that prophecy. The volume of the poetry written, either in this country or abroad, with that inspiration is but slight. Tennyson gave us some thoughts suggested by the doctrine of evolution, Matthew Arnold some others. On the whole, Sully Prudhomme has come nearest to Wordsworth's ideal of the poet inspired by science, but it takes with him the guise of a stern, sad doctrine of resignation and fortitude under inexorable laws. It remained for Mr. Noyes to strike a new note, of triumph in the growth of the human spirit, of patient search for truth, of romantic beauty in the linking up of relationships between the heavenly bodies, which have inspired the worship and wonder of man since he first looked upwards.

The figures Mr. Noyes has chosen for the protagonists of his drama have all some points of personal interest, as well as permanent importance in the building up of science. These personal aspects he rightly stresses. Copernicus is described upon his death-bed, waiting for the issue of his long-delayed work. Kepler is the fantastic poet, visited by Sir Henry Wotton, who quotes verse for verse. The trial of Galileo—dramatically the most effective thing in the poem—is given in the form of letters from his daughter Celeste and from others, friends and foes, somewhat in the manner of Browning.

It is tempting to quote some of the most telling lines in the poem; one reviewer, at any rate, has read some of them several times already. Two extracts only shall be given, not by any means as among the most beautiful, but as conveying the dominating spirit of the whole. The Prologue raises the question, is there